Gauge Block

INTERLABORATORY COMPARISON

APLAC M 022

Final Report

June 2014

ACKNOWLEDGEMENTS

The APLAC Secretariat wishes to acknowledge gratefully to the APLAC members for their participation and cooperation, National Standardization Council- Office of the National Standardization Council (NSC-ONSC) for its contribution and National Institute of Metrology (Thailand) (NIMT) who acted as collaborator for assigning reference values on artifact.

Contents

Appendices

1. Introduction

This report summarizes the results of an interlaboratory comparison on Gauge Block calibration by accredited laboratories / applicant laboratories with accreditation bodies those are members of the Asia-Pacific Laboratory Accreditation Cooperation (APLAC). The program was coordinated by the National Standardization Council- Office of the National Standardization Council (NSC-ONSC) with technical support of National Institute of Metrology (Thailand) (NIMT).

This program was carried out from September 2011 to September 2012.

2. Aim of the program

One of APLAC's main aims is to build and maintain mutual confidence in the technical competence of APLAC members. Interlaboratory comparisons provide objective evidence that laboratories are competent enough to achieve the level of the accuracy they are accredited for. It also provides a means for improving the quality and performance of laboratories throughout the region.

3. Design of the program

To enable the maximum calibration laboratories participation, NSC-ONSC designed, two loops for circulation, each having two sets of steel gauge blocks with nominal values 175 mm, 200 mm and 300 mm as travelling standards

Participating laboratories were required to measure the central length of all three gauge blocks under the normal conditions and to report the deviations from assigned nominal length to NSC-ONSC.

The reference values of artifacts were assigned by NIMT with sufficiently small uncertainty (see Appendix D)

Detailed instructions for the measurements were circulated to participating laboratories. The procedures for reporting surface conditions of artifacts as a monitor means for checking validity of artifacts was also given. A copy of the Instructions to Laboratories appears in Appendix B.

4. Participants

A total of eighteen laboratories from eleven accreditation bodies participated in this program. A circulation schedule (Appendix C) shows the name and economy of participating accreditation bodies. To maintain confidentiality, participating laboratories were assigned a random code number and these numbers are used in this report. Table 1 shows the number of participating laboratories and their accreditation bodies.

There were some delays encountered in the circulation of the artifacts due to customs clearance procedures in some of the participating countries.

Table 1 Number of participants

Calibration method used	The number of Labs	The number of ABs
Comparison measurement method	18(3)	11(1)

*The number inside of the parenthesis indicates the number of laboratories that had been registered but did not actuary participate, and exclude from the number of participants.

5. Reporting by participants

Laboratories were requested to report the measurement results with associated uncertainties at approximately 95% confidence level in the format '*Results Sheet'* and to submit the *Surface Condition Report of Gauge blocks* (refer to Appendix B). They were also asked to provide Calibration Certificates for to make sure their accreditation status.

6. Artifacts

6.1 Specification of the artifacts

The specification of the artifacts is shown in the Appendix B.

6.2 Stability of the artifacts

After initial calibration of the artifacts by NIMT, they were sent to all the participating laboratories. And after complete round of circulation, the artifacts were again calibrated by NIMT for checking their validity and stability.

The differences of measured values of all gauge blocks using comparison measurement before and after circulation were less than their expanded uncertainties, therefore they were deemed to be sufficiently stable during circulation.

The result of the stability study of the artifacts is shown in Appendix D.

7. Reference values

The lengths of gauge blocks under calibration were determined by comparison with a reference gauge block having the same nominal length, using a Universal Length Measuring Machine (ULM). The determination of length from the central length (Dlc) is measured at the center point based on ISO 3650:1998.

The different of the reference values at start of program and at the end after circulation is not significant. Therefore the reference values assigned for this program are obtained from the average of the two calibration values with their associated measurement uncertainty.

The uncertainties stated are the expanded uncertainty obtained by multiplying the standard uncertainty by the coverage factor k= 2. They have been determined in accordance with EA publication EA-4/02 "Expression of the Uncertainty of Measurement in Calibration" and JCGM 100:2008 "Evaluation of measurement data – Guide to the expression of uncertainty in measurement (GUM 1995 with minor corrections)" The values of the measurand lie within the assigned range of values with a probability of 95%.

The reference values are traceable to the national standards, which realize the unit of measurement to the International System of Units (SI).

8. Summary of the results

The measurement results reported by the participating laboratories are summarized in the table 2 to 7 below along with the performance analysis in terms of E_n number.

The graphs in Figures 1 to 6 indicate the difference between each laboratory's result and the reference value (X_i-X_{ref}) with its associated uncertainty.

In accordance with international practice, performance of a participating laboratory has been assessed in terms of E_n number for each measurement. The E_n number is calculated using a standard statistical technique for comparing values and are derived from the equation (1).

$$E_n = \frac{x_i - X_{REF}}{\sqrt{U_{LAB,i}^2 + U_{REF}^2}} \qquad (1)$$

Where

X_i	=	Deviation of central length from nominal length reported by participants (μm)
X_{REF}	=	Deviation of central length from nominal length reported by reference laboratory (μm)
$U_{LAB,i}$	=	The expanded measurement uncertainty of x_i that provides an interval having a confidence level of approximately 95% (coverage factor k=2) (μm)
U_{REF}	=	The expanded measuring uncertainty of X_{REF} that provides an interval having a confidence level of approximately 95% (coverage factor k=2) (μm)

For the results to be acceptable, the E_n number should lie between -1 to +1.

Table 2 Results for the measurement (loop A)

Gauge block : 175 mm

Lab code	REF	A-01	A-02	A-03	A-04	A-05	A-06
Deviation of central length from nominal length (μm)	-0.32	-0.19	-0.2	-0.08	-0.11	-0.26	-0.35
X_{lab}-$X_{ref\ (\mu m)}$		0.13	0.12	0.24	0.21	0.06	-0.03
Coverage factor; k	2	2	1.97	2	2	2	2
Expanded uncertainty (μm)	0.13	0.44	0.8	0.39	0.255	0.25	0.48
En-number		0.28	0.15	0.58	0.73	0.21	-0.06

Table 3 Results for the measurement (loop A)

Gauge block : 200 mm

Lab code	REF	A-01	A-02	A-03	A-04	A-05	A-06
Deviation of central length from nominal length (μm)	-0.42	-0.26	-0.4	-0.16	-0.34	-0.35	-0.31
X_{lab}-$X_{ref\ (\mu m)}$		0.16	0.02	0.26	0.08	0.07	0.11
Coverage factor; k	2	2	1.97	2	2	2	2
Expanded uncertainty (μm)	0.14	0.5	0.9	0.42	0.282	0.27	0.54
En-number		0.31	0.02	0.59	0.25	0.23	0.20

Table 4 Results for the measurement (loop A)

Gauge block : 300 mm

Lab code	REF	A-01	A-02	A-03	A-04	A-05	A-06
Deviation of central length from nominal length (μm)	-0.15		0.1	0.14	0.24	0.15	0.42
X_{lab}-$X_{ref\ (\mu m)}$			0.25	0.29	0.39	0.3	0.57
Coverage factor; k	2		1.97	2	2	2	2
Expanded uncertainty (μm)	0.19		1.3	0.51	0.392	0.35	0.78
En-number			0.19	0.53	0.9	0.75	0.71

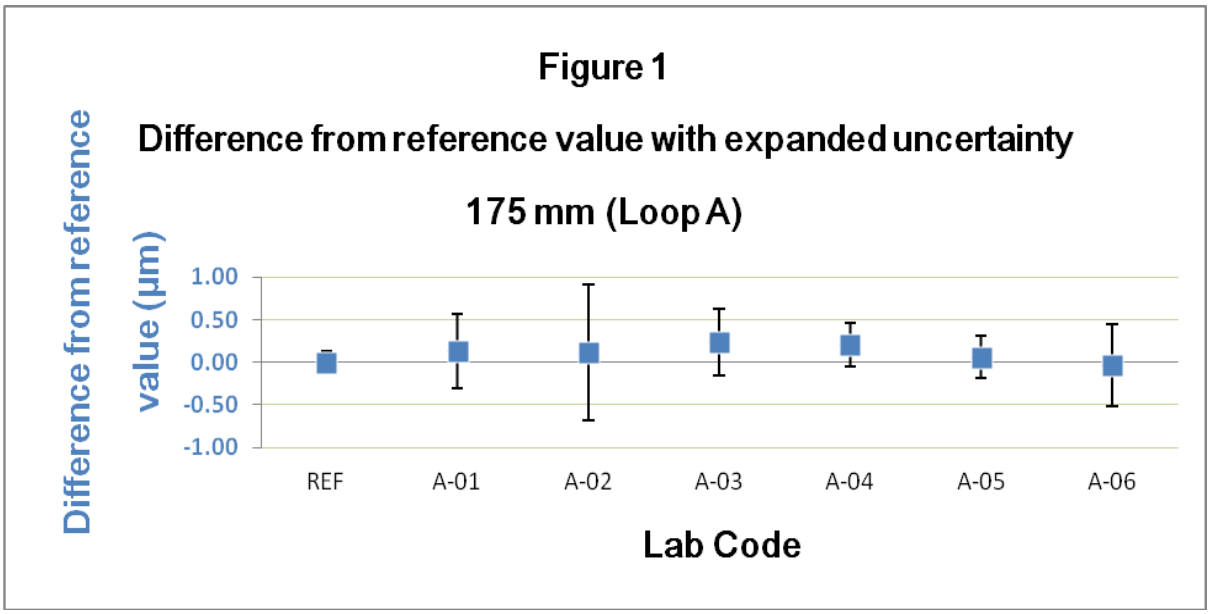
Table 5 Other reported information (loop A)

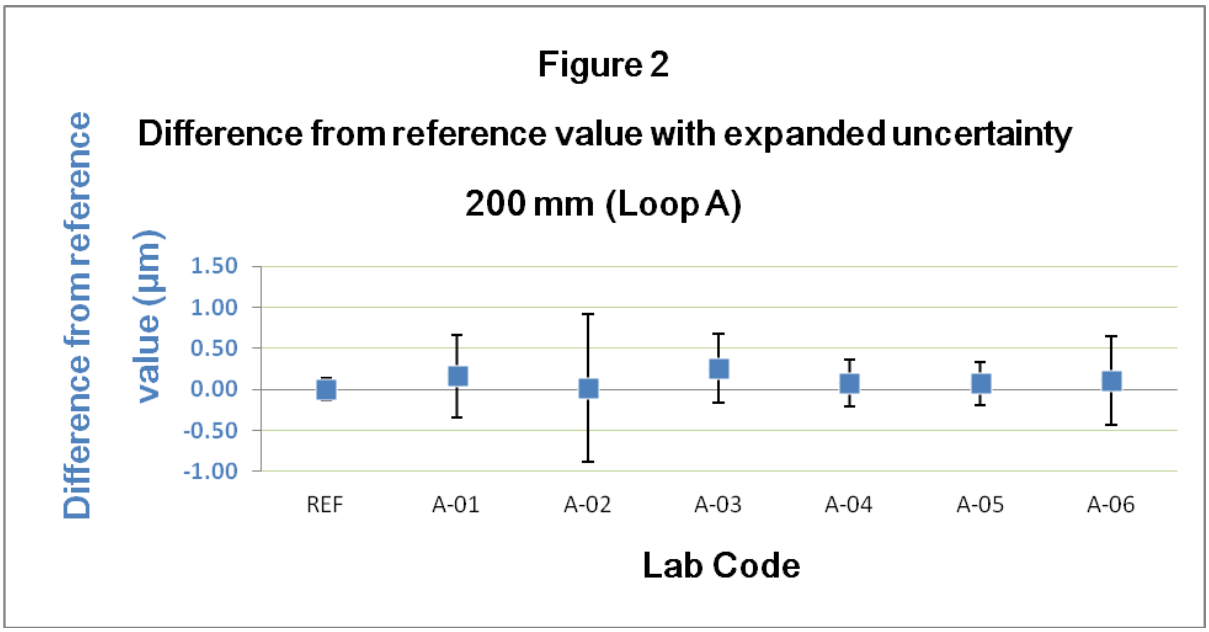
Lab code	REF	A-01	A-02	A-03	A-04	A-05	A-06
Reference standard		1*	1*	2*	3*	3*	1*
Temperature (°C)		(20±1)	(20±1)	68.3°F	(20±1)	(20±0.5)	(20±1)
Thermal expansion coefficient (10^{-6}/K)		10.9	(11.6±1)	(11.6±1)	(11.6±1)	(11.6±1)	(11.6±1)

1* : Steel Gauge block (Grade K)

2*: Steel Gauge block (Grade 0)

3*: Steel Gauge block





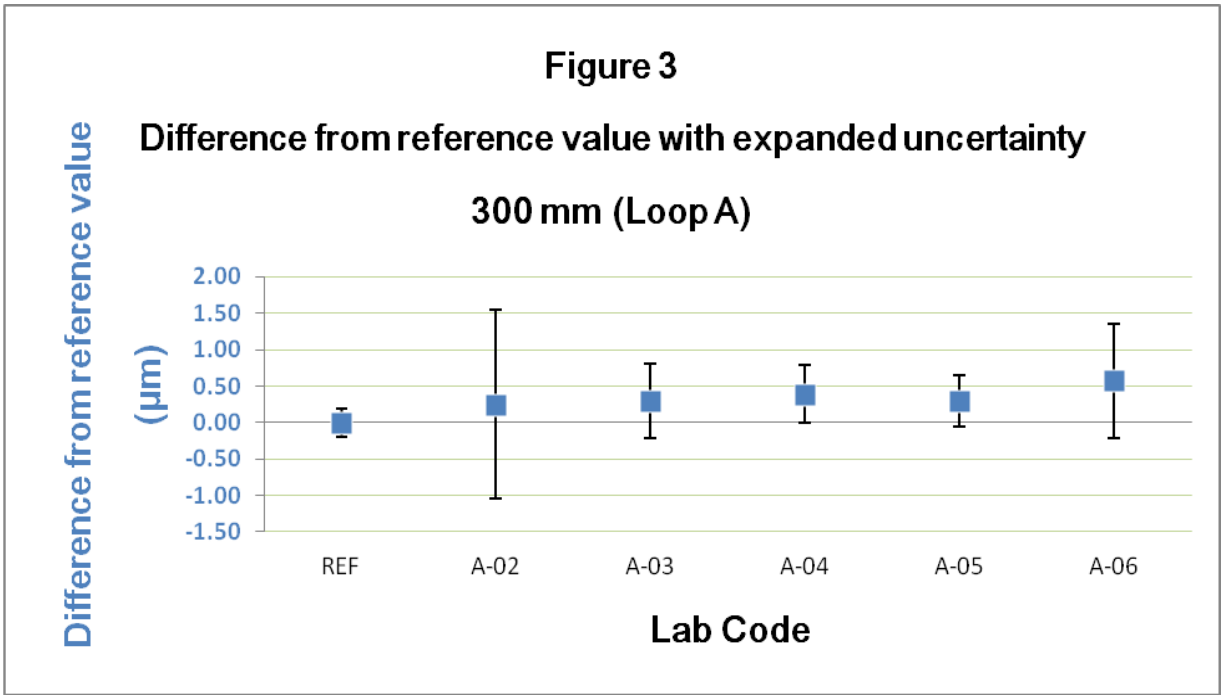


Table 6 Results for the measurement (loop B)

Gauge block : 175 mm

Lab code	REF	B-01	B-02	B-03	B-04	B-05	B-06
Deviation of central length from nominal length (µm)	-0.11	0.04	-0.33	-0.44	-0.22	-0.15	-0.17
X_{lab}-$X_{ref\ (\mu m)}$		0.15	-0.22	-0.33	-0.11	-0.04	-0.06
Coverage factor; k	2	2	2	2	2	2	2
Expanded uncertainty (µm)	0.13	0.36	0.54	0.52	0.33	0.36	0.38
En-number		0.39	-0.40	-0.62	-0.31	-0.10	-0.15

Lab code	REF	B-07	B-08	B-09	B-10	B-11	B-12
Deviation of central length from nominal length (µm)	-0.11	-0.004	-0.02	-0.18	-0.18	0.3	-0.04
X_{lab}-$X_{ref\ (\mu m)}$		0.106	0.09	-0.07	-0.07	0.41	0.07
Coverage factor; k	2	2	1.98	2	2	2	1.97
Expanded uncertainty (µm)	0.13	0.267	0.29	0.17	0.18	0.6	0.37
En-number		0.36	0.28	-0.33	-0.32	0.67	0.18

Table 7 Results for the measurement (loop B)

Gauge block : 200 mm

Lab code	REF	B-01	B-02	B-03	B-04	B-05	B-06
Deviation of central length from nominal length (μm)	-0.13	0.29	-0.53	1.11	-0.21	-0.24	-0.07
X_{lab}-$X_{ref\ (\mu m)}$		0.42	-0.4	1.24	-0.08	-0.11	0.06
Coverage factor; k	2	2	2	2	2	2	2
Expanded uncertainty (μm)	0.14	0.42	0.6	0.54	0.35	0.38	0.42
En-number		0.95	-0.65	2.22	-0.21	-0.27	0.14

Lab code	REF	B-07	B-08	B-09	B-10	B-11	B-12
Deviation of central length from nominal length (μm)	-0.13	0.131	-0.01	-0.24	-0.21	-0.4	-0.27
X_{lab}-$X_{ref\ (\mu m)}$		0.261	0.12	-0.11	-0.08	-0.27	0.01
Coverage factor; k	2	2	1.98	2	2	2	1.97
Expanded uncertainty (μm)	0.14	0.287	0.30	0.19	0.19	0.6	0.40
En-number		0.82	0.36	-0.47	-0.34	-0.44	-0.08

Table 8 Results for the measurement (loop B)

Gauge block : 300 mm

Lab code	REF	B-01	B-02	B-03	B-04	B-05	B-06
Deviation of central length from nominal length (μm)	-0.28	0.15	-0.51	-0.16	-0.12	0.08	0.12
X_{lab}-$X_{ref\ (\mu m)}$		0.43	-0.23	0.12	0.16	0.36	0.4
Coverage factor; k	2	2	2	2	2	2	2
Expanded uncertainty (μm)	0.19	0.52	0.86	0.67	0.43	0.53	0.57
En-number		0.78	-0.26	0.17	0.34	0.64	0.67

Lab code	REF	B-07	B-08	B-09	B-10	B-11	B-12
Deviation of central length from nominal length (μm)	-0.28	0.069	0.04	-0.1	-0.12	1.2	-0.27
X_{lab}-$X_{ref\ (\mu m)}$		0.349	0.32	0.18	0.16	1.48	0.01
Coverage factor; k	2	2	1.98	2	2	2	1.97
Expanded uncertainty (μm)	0.19	0.367	0.38	0.28	0.26	0.8	0.55
En-number		0.84	0.75	0.53	0.50	1.80	0.01

Table 9 Other reported information (loop B)

Lab code	REF	B-01	B-02	B-03	B-04	B-05	B-06
Reference standard		2*	3*	3*	1*	3*	1*
Temperature (°C)		20.1	(20±1)	20.1	(20±0.3)	(20±1)	(20±0.5)
Thermal expansion coefficient (10^{-6}/K)		11.6±1	11.6±1	11.6±1	11.6±1	11.6±1	11.6±1

Lab code	REF	B-07	B-08	B-09	B-10	B-11	B-12
Reference standard		4*	2*	3*	3*	3*	3*
Temperature (°C)		68.2 °F	19.7-19.9	20.0	(20±0.2)	18.8-21.6	20.0
Thermal expansion coefficient (10^{-6}/K)		11.6±1	11.6±1	11.6±1	11.6±1	11.6±1	11.6±1

1* : Steel Gauge block (Grade K)

2*: Steel Gauge block (Grade 0)

3*: Steel Gauge block

4* : Steel Gauge block (Grade 1)

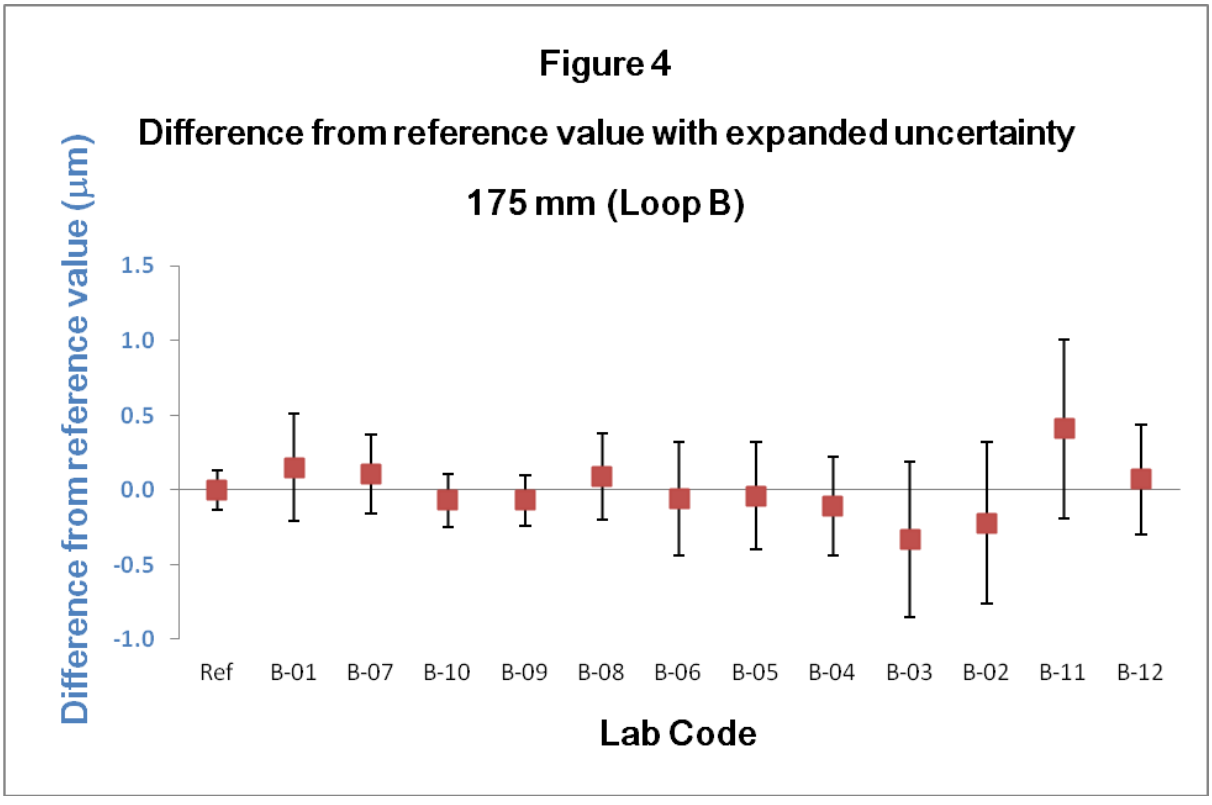


Figure 5

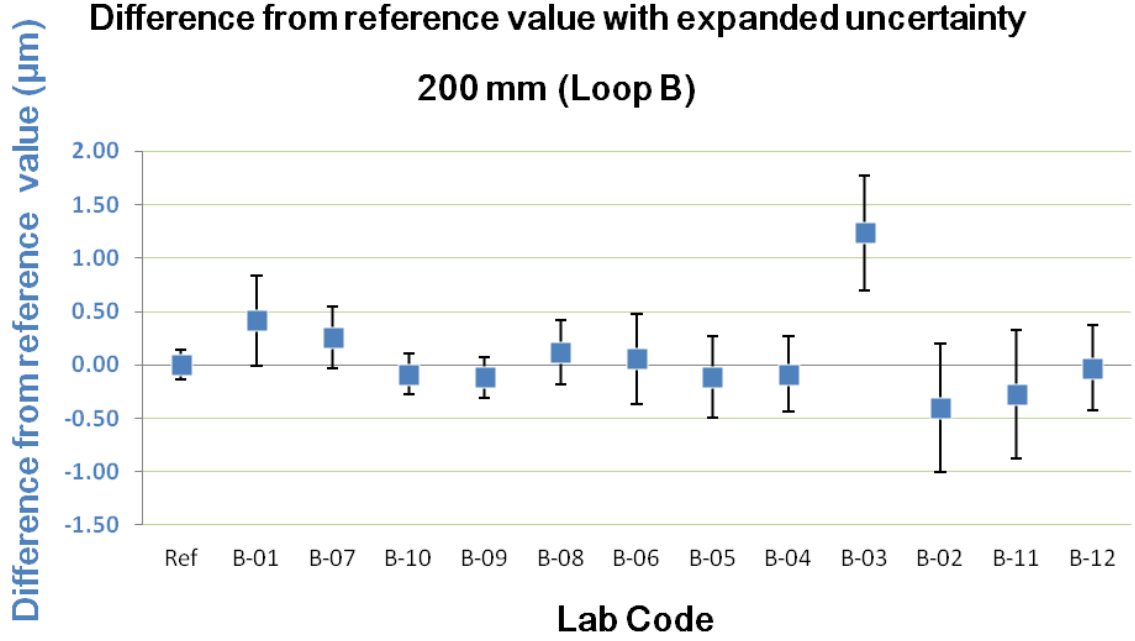
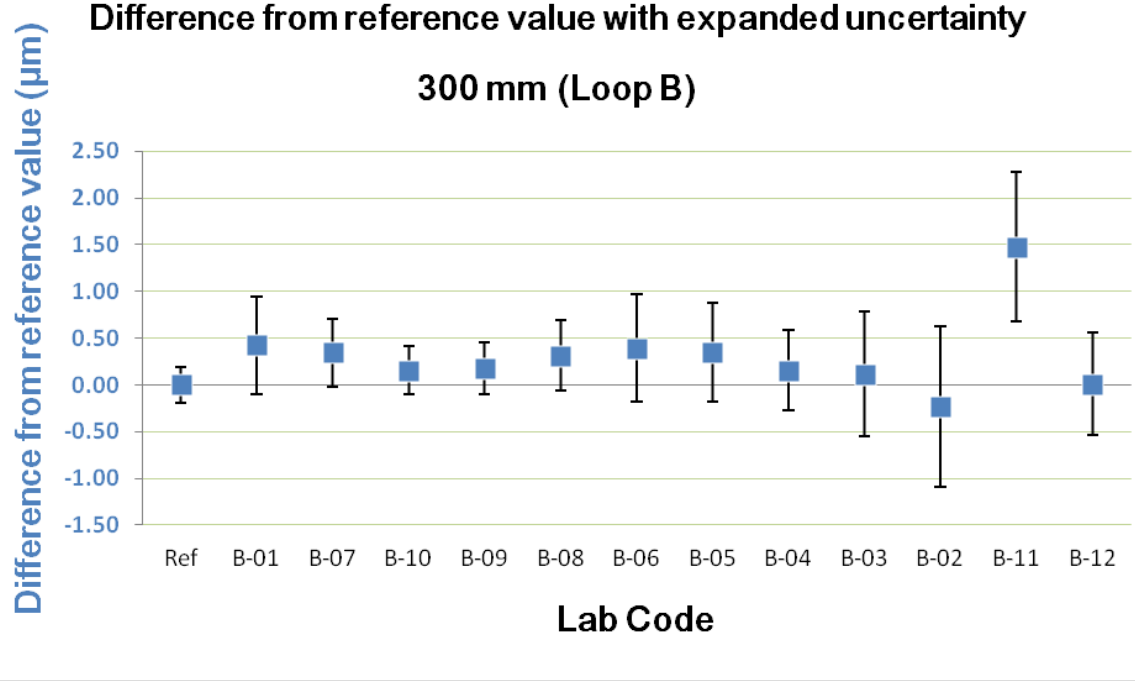


Figure 6



9. Performance of participants

The *En* numbers in tables in Section 8 show overall good performance by the majority of laboratories.

The summary of performance of participating laboratories is given below –

Circulation Loop A

Nine laboratories were registered to participate in this loop by using comparison measurement method. Three laboratories could not carry out the calibrations and did not report the results because of troubles in measurement equipment and environment condition. One laboratory (A-01) did not report measurement result of 300 mm gauge block due to issues related to its measurement capability.

The absolute value of the *En* numbers for all measurement results on 175 mm, 200 mm and 300 mm gauge blocks were reported not exceed than +1.

Circulation Loop B

Twelve laboratories were registered to participate in this loop by using comparison measurement method and reported the results from B01-B12.

The absolute value of the *En* number for the measurement result on 200 mm gauge block by Lab B-03 exceeded than +1. Similarly, the absolute value of the *En* number for the measurement result on 300 mm gauge block by Lab B-11 exceeded than +1. Rest En values found in acceptable range of ± 1

10. Technical comments

10.1 Overview of comparison measurement

The data of the reference laboratory and the participant laboratories do not show any problem which might affect the overall evaluation of the result. Therefore, it is assumed that circulation of artifacts has been appropriately completed and the stability of artifacts during circulation was acceptable.

The following factors may be presumed as examples that might affect the measurement results and lead to absolute value of *En* greater than 1

a) Miscalculation

b) Influence by gauge block comparator or Universal Length Measuring Machine (ULM)

c) Influence by standard gauge block with its uncertainty

d) Thermal influence and deformation influence due to material difference between reference standard and the artifact

e) Influence by long term drift of reference standard

10.2 Uncertainty of measurement

The more common sources of systematic error and uncertainty in gauge block calibration by using a comparator & a calibrated gauge block of the same nominal length and of same material as of reference standard are as followings:

a) Type A evaluation of standard uncertainty

b) Imported uncertainty from standard gauge block

c) Drift or stability of standard gauge block (referred to ISO3650, Second edition, Dimensional Stability)

d) Accuracy of comparator or ULM

e) Resolution of comparator or ULM

f) Temperature effects

g) Length variation of unknown gauge block

10.3 Other comments on the reported results

Results reported and the calibration certificates submitted by the participating laboratories were compared for their accuracy in data transfer. There is no major comment except that one laboratory has reported the unit of the standards used in Imperial Unit (e.g. inch) in its calibration certificate.

The measured value of 200 mm gauge block reported by B-03 shows that the absolute value of *En* number is more than 1which should be investigates for taking corrective action.

The measured value of 300 mm gauge block reported by B-11 shows that the absolute value of *En* number is more than 1 which should be investigated for taking corrective action.

11. Corrective action

For the purpose of this international interlaboratory comparison program, the participants are requested to identify the root cause of the outliers and to take appropriate corrective actions against the outliers results, . The root cause for the outlier results may vary between the situations of measurement. Primary responsibility to rectify the problem lies with the participating laboratories and their accreditation bodies. Hence this report does not contain any comments on the corrective actions reported or to be done by the outlier laboratories. The participating accreditation bodies are strongly recommended to ensure that the root causes are rectified and proper measures are put in place by the laboratories against their poor performance.

12. References

1) ISO 3650 :1998 *Geometrical Product Specifications (GPS)- Length Standards – Gauge blocks*

2) APLAC M 018 Short Gauge Block, December 2007

3) ISO/IEC 17043 :2010 Conformity assessment – General requirements for proficiency testing

4) EA-4/02 M:2013 Evaluation of the Uncertainty of Measurement in Calibration, September 2013 rev01

APPENDIX A

INSTRUCTION TO ACCREDITATION BODIES

APLAC INTERLABORATORY COMPARISON

PROFICIENCY TESTING PROGRAM

APLAC M 022

Gauge Block

INSTRUCTION TO

ACCREDITATION BODIES

A. INSTRUCTIONS TO ACCREDITATION BODIES

1. EQUIPMENT

On receipt, unpack the artifacts and inspect them for any defects like surface scratch, wear or corrosion. Please refer to "*INSTRUCTIONS TO LABORATORIES*" for the details of artifacts and documentations enclosed.

Complete the attached "RECEIPT FORM" and fax and/or e-mail to the organizing body.

Please note, these instructions and attached Results Sheet are master copies and must remain in the box from country to country. The national accreditation body should make copies for distribution to the participating laboratories in their country.

2. TRANSPORT

The artifacts can be carried by hand, car or by plane, whatever is considered the safest way. Transport to the next accreditation body should be by a reliable international courier with a user accessible tracking system. Door-to-door delivery must be specified. Transportation cost should be covered by each participating accreditation body which sends the artifacts to the next economy or the Reference Laboratory.

3. CUSTOMS

NO ATA Carnet is provided with these artifacts. A "Declaration to Customs Officials and Shipping Agents" is enclosed in the plastic envelope attached to the outside of the box. Please make it is in place before dispatching to the next country otherwise it will not pass through their Customs authorities. Please attach 3 extra photocopies of the Declaration.

4. MEASUREMENTS TO BE CARRIED OUT

Please refer to "INSTRUCTIONS TO LABORATORIES" enclosed. If necessary, these should be translated into the appropriate language by the accreditation body.

5. CIRCULATION SCHEME

At the beginning and at the end of the circulation scheme, measurements will be performed by the reference laboratory (The National Institute of Metrology (Thailand), NIMT)

It is the responsibility of the accreditation body to make sure that the artifacts are dispatched to the next participant by the date specified. Two weeks are allowed for each international transport and customs clearance. If a delay occurs with one laboratory then the number of participating laboratories in that country will have to be reduced so that the artifacts leave by the scheduled date. When ready for dispatch, fill in the attached "DISPATCH FORM" and fax and/or e-mail to the next participant and to NSC-ONSC.

6. DOCUMENTS TO BE SUBMITTED

Within one week of the completion of the measurements, participating laboratories are required to fax or send *the Results Sheet, Surface Condition Report of Gauges, and their Calibration Certificate* to their accreditation body. No other documentation is required. The accreditation body is required to ensure that *the Results Sheet, Surface Condition Report of Gauges and their Calibration Certificate* have been filled in correctly and completely. The accreditation body should provide details of any problems that their laboratories had. The accreditation body is required to fax and/or e-mail the documentation to the NSC-ONSC within two weeks of dispatching the artifacts.

On receipt of the information, NSC-ONSC will prepare interim reports on each laboratory which are then sent back to the national accreditation body. A final report will be issued at the end of the program with each laboratory only identified by a **confidential** code number.

Laboratories are required to submit *Surface Condition Report of Gauges* twice, i.e. (1) when they receive the artifacts and (2) when they submit the results of measurement to Accreditation Body. Accreditation Bodies are required to send *these two sheets of Surface Condition Report of Gauges with Results Sheet and Calibration Certificate* to NSC-ONSC.

7. GENERAL INFORMATION

Please contact:

Ms. Utumporn Kaewnamdee

Laboratory Accreditation Group,

The Office of National Standardization Council

Thai Industrial Standards Institute (TISI)

Rama 6 Rd., Ratchathewee, Bangkok Thailand 10400

Phone No.: +66-2-202-3491

Fax No.: +66-2-354-3045

E-mail: utumporn@tisi.go.th

B. RECEIPT FORM

APLAC INTERLABORATORY COMPARISON APLAC M022

In order to monitor the progress of the interlaboratory comparison, we kindly ask each accreditation body, on receipt of the artifacts, to fill in this *RECEIPT FORM* and fax and/or e-mail it to:

Ms. Utumporn Kaewnamdee

Thai laboratory Accreditation Group,

The Office of National Standardization Council (ONSC),

Thai Industrial Standards Institute (TISI)

Phone No.: +66-2-202-3491

Fax No.: +66-2-354-3045

Email : utumporn@tisi.go.th or utumporn_tisi@yahoo.com.sg

Thank you in advance for your cooperation.

The APLAC M022 artifacts were received on: _____ *(date)*

After inspection, are the contents damaged? _____ *(yes/no)*

If yes, is this serious? _____ *(yes/no)*

Are the contents still suitable for use? _____ *(yes/no)*

Was there a "*Declaration to Customs Officials and Shipping Agents*" enclosed in the plastic envelope attached to the outside of the case? _____(*yes/no)*

Remarks: _____

_____

Participating accreditation body: _____

Contact person: _____

Fax: _____Circulation group: ___

C. DISPATCH FORM

APLAC INTERLABORATORY COMPARISON APLAC M022

In order to monitor the progress of the interlaboratory comparison, we kindly ask each accreditation body, on dispatch of the artifacts, to fill in this *DISPATCH FORM* and fax and/or e-mail it to:

Ms. Utumporn Kaewnamdee

Thai laboratory Accreditation Group,

The Office of National Standardization Council (NSC-ONSC),

Thai Industrial Standards Institute (TISI)

Phone No.: +66-2-202-3491

Fax No.: +66-2-354-3045 Email : Utumporn@tisi.go.th or utumporn_tisi@yahoo.com.sg

and also fax and/or e-mail it to the next participating accreditation body :

Name: _____

Accreditation body: _____

Fax_____

Please ensure that the "*Declaration to Customs Officials and Shipping Agents*" is attached to the outside of the case. Thank you in advance for your cooperation.

The APM-022 artifacts were dispatched on: _____*(date)*

The artifacts have been inspected after return from our laboratories and were found to be in good condition. _____ (yes/no)

Please give details of any problems: _____

Shipping agent: _____ Phone: _____ Fax: _____

Airway bill no. (or consignment note no.): _____

Your accreditation body: _____

Contact person: _____

Fax: _____

D. DECLARATION TO CUSTOMS OFFICIALS AND SHIPPING AGENTS

This document must stay with the box

ASIA PACIFIC ECONOMIC COOPERATION (APEC)

APLAC INTERLABORATORY COMPARISON – APM 022

This box contains scientific equipment for an international interlaboratory comparison coordinated by The Office of National Standardization Council (ONSC) on behalf of the Asia Pacific Laboratory Accreditation Cooperation (APLAC). APLAC is classed as a Specialist Regional Body under the APEC Sub-Committee on Standards and Conformity Assessment.

This instrument is of the highest accuracy and should not be dismantled. If a customs inspection is required then please contact the person nominated on the back of this form so that they can be present. Details of the contents of the box are listed below. The contents are not hazardous in any way.
The equipment is for scientific purposes only and no commercial transactions will take place. The box will remain in each country for approximately 6 weeks and then it will be re-exported, hence no import duty or taxes are payable. Details of the participating laboratory accreditation bodies in each country are given on the next page.

CONTENTS OF THE BOX

Item Description

Content	Nominal length (mm)	Material	Manufacturer
Gauge Block (Grade o)	175, 200 and 300	Steel	Mitutoyo
Wooden Inner Box	-	Wood	-

COMMERCIAL VALUE: $ NIL **MATERIAL VALUE: USD** 1940

TOTAL BOX WEIGHT: 8.7 kg **BOX DIMENSIONS:**

I declare that the above particulars are true and correct.

_____ _____

Ms. Utumporn Kaewnamdee
Thai laboratory Accreditation Group,
The Office of National Standardization Council (ONSC),
Thai Industrial Standards Institute (TISI)
Phone No.: +66-2-202-3491
Fax No.: +66-2-354-3045
Email : utumporn@tisi.go.th or utumporn_tisi@yahoo.com.sg

APPENDIX B

INSTRUCTIONS TO LABORATORIES

APLAC INTERLABORATORY COMPARISON

PROFICIENCY TESTING PROGRAM

APLAC M 022

Gauge Block

INSTRUCTIONS TO LABORATORIES

INSTRUCTIONS TO LABORATORIES

1. EQUIPMENT

Group	Content	Serial No.	Nominal Length	Material	Manufacturer
…….	Gauge Blocks	……..	175 mm	Steel	Mitutoyo
		…….	200 mm		
		…….	300 mm		
	Wooden Inner Box	…….	-	Wood	YPG, UK
	Portable Transit Case	-	-	Aluminum	Daedo, Korea
	Material property of Gauge Blocks : Coefficient of Thermal expansion: 11.6×10^{-6} /K				

On receipt, unpack the artifacts and inspect them for any defects. Make sure to sketch surface condition of all the artifacts on the "*Surface Condition Report of Gauges*". Contact your accreditation body if there is any damage. Send "*Surface Condition Report of Gauges*" by fax and/or e-mail right away to your accreditation body.

2. MEASUREMENTS TO BE CARRIED OUT

Before calibration, the gauge blocks have to be inspected for damage of the measurement surfaces. Any scratches, rusty spots or other damages have to be documented by a drawing using the appropriate form in Surface condition report of Gauges. Measurement item is the central length of the gauge blocks, as defined in the International Standard ISO 3650. The measurement results must be appropriately corrected to the reference temperature of 20 $^{\circ}$C using the thermal expansion coefficients given. Additional correction for the contact deformation has to be applied according to the usual procedure of the laboratory if necessary. Measurement uncertainty (U) shall be reported by using expanded measurement uncertainty. Coverage factor shall be a value which defines an interval having a level of confidence of approximately 95 %.

After the measurements, the artifacts must be cleaned, greased, and carefully re-packaged in the original container.

3. DOCUMENTS TO BE SUBMITTED

Within one week of the completion of the measurements, participating laboratories are required to send the attached "Results Sheet", "Surface condition report of Gauges", and their calibration report to their accreditation body. No other documents are required. Laboratories should make a copy of the Results Sheet for their own records.

Where possible, uncertainties should be calculated using the method in the *ISO Guide to the Expression of Uncertainty in Measurement.*

4. GENERAL INFORMATION

For general queries, please contact your accreditation body.

Additional information may be obtained from the program coordinator below:

Ms Utumporn Kaewnamdee

Thai laboratory Accreditation Gruop,

The Office of National Standardization Council (ONSC)

Thai Industrial Standards Institute (TISI)

Rama 6 Rd., Ratchathewee, Bangkok Thailand 10400

Phone No.: +66-2-202-3491

Fax No.: +66-2-354-3045

E-mail: utumporn@tisi.go.th or utumporn_tisi@yahoo.com.sg

SURFACE CONDITION REPORT OF GAUGE BLOCKS

Date:

Name of participant:

Circulation group:

Name of accreditation body:

Please mark: □ on receipt □ after mesurement

Any scratches ?

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

NOTE: Photograph may be helpful to describe damages well.

RESULTS SHEET

Name of participant: _____

Circulation group: _____ Lab Code……

Date of measurement: _____

Environment: 1. Temperature _____ 2. Humidity _____

Reference standard (type, S/N, material):

_____

_____

_____

Name of accreditation body: _____

Results:

Nominal length (mm)	Gauge block S/N	Deviation of central length from nominal length (μm)	Measurement uncertainty U (μm)	Coverage factor k	Remarks
175					
200					
300					

NOTE:

1. Diameter must be reported as a value at the reference temperature of $t_o = 20$ °C

2. Measurement uncertainty (U) shall be reported by using expanded uncertainty.

3. Coverage factor shall be a value which defines an interval having a level of confidence of approximately 95 %.

4. Thermal expansion coefficient: $(11.6 \pm 1.0) \times 10^{-6}$ /K

5. Use SI unit only.

Signature of responsible person: _____

Date: _____ / _____ / _____ (dd /mm/yyyy)

APPENDIX C

CIRCULATION TIME SCHDULE

CIRCULATION TIME SCHDULE

1. Loop A

Economy	Accreditation body	Receipt	Dispatch	No. of LAB(S)
Thailand (Ref)	NIMT (Ref)			
Malaysia	DSM	29 August 2011		1
Japan	IAJapan	15 September 2011	28 October 2011	1(2)
USA	ACLASS	31 October 2011		1(2)
Canada	NRCC			2
Hongkong	HKAS	26 March 2012	26 April 2012	1
Vietnam	BOA		10 May 2012	0(1)
Thailand (Ref)	NIMT (Ref)			
			Total labs	6(3)

* The number inside of the parenthesis indicates the number of laboratories that had been registered but did not actuary participate, and excluded from the number of participants.

2. Loop B

Economy	Accreditation body	Receipt	Dispatch	No. of LAB(S)
Thailand (Ref)	NIMT (Ref)			
New Zealand	IANZ	18 August 2011	19 October 2011	2
USA	A2LA	24 October 2011	8 November 2011	1
China	CNAS	22 November 2011	not reported	2
Taiwan	TAF	19 December 2011	6 January 2012	2
Thailand	NSC-NSC-ONSC	12 February 2012	20 August 2012	5
Thailand (Ref)	NIMT (Ref)			
			Total labs	12

* The number inside of the parenthesis indicates the number of laboratories that had been registered but did not actuary participate, and excluded from the number of participants.

APPENDIX D
ARTIFACTS STABILITY

ARTIFACTS STABILITY

1. Loop A - Stability Comparison Measurement

Reference Laboratory : NIMT

Nominal Length of Gauge Block (mm)	Value of Before Circulation V_b (μm)	Value of After Circulation V_a (μm)	Va-Vb (μm)	Expanded Uncertainty (k=2) (μm)
175	-0.30	-0.34	-0.04	0.13
200	-0.43	-0.41	0.02	0.14
300	-0.19	-0.11	0.08	0.19

2. Loop B - Stability Comparison Measurement

Reference Laboratory : NIMT

Nominal Length of Gauge Block (mm)	Value of Before Circulation V_b (μm)	Value of After Circulation V_a (μm)	Va-Vb (μm)	Expanded Uncertainty (k=2) (μm)
175	-0.11	-0.11	0.00	0.13
200	-0.12	-0.13	-0.01	0.14
300	-0.23	-0.32	-0.09	0.19